MIGRATION AND BEHAVIOUR OF NON-REPRODUCTIVE *DANAUS PLEXIPPUS* (L.) (LEPIDOPTERA: NYMPHALIDAE) IN THE BLUE MOUNTAINS, NEW SOUTH WALES

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Abstract

The behaviour and movement of mass-released, non-reproductive *Danaus plexippus* (L.) in the Blue Mountains, New South Wales was studied during autumn and winter 1984. An easterly migration into the Sydney basin occurred during warm weather in March and April. Movement of up to 75 km was recorded and three individuals were recovered from an overwintering colony of *D. plexippus* at Wallacia. The advent of cooler weather during May-July inhibited long distance movement, resulting in the formation of a local population which displayed behaviour characteristic of overwintering, non-reproductive *D. plexippus*.

Introduction

Wanderer or monarch butterflies, *Danaus plexippus* (L.) overwinter in the Sydney area of New South Wales as reproductive or non-reproductive individuals (Smithers 1965, James 1979, 1981, 1984a). Non-reproductive populations form when newly-emerged butterflies experience cool, cloudy conditions during late summer and autumn (James 1983). These individuals subsequently migrate coastward and establish overwintering colonies at sites in the Sydney basin and Hunter Valley (Smithers 1965, James 1982, 1983, 1984b, 1984c). Circumstantial evidence indicates that many butterflies in these colonies originate from highland and tableland areas to the west and south-west of Sydney, such as the Blue Mountains (see James 1982, 1983, 1984a, 1984b). In addition, a recent study (James 1986a), showed that migrating *D. plexippus* during late summer and autumn in Sydney, invariably travel in a northerly to easterly direction. However, despite widespread tagging of populations over the past two decades (Smithers 1972 and pers. comm., James 1984a), no direct evidence of the origin of individuals in overwintering colonies has been obtained.

This study presents data on the migration and behaviour of mass released, non-reproductive *D. plexippus* during autumn and winter 1984 in the Blue Mountains.

Methods

Due to the practical difficulties of rearing sufficient numbers of butterflies to generate meaningful results, individuals from wild non-reproductive populations were used in this study. During March-July 1984 *D. plexippus* were obtained at weekly or fortnightly intervals from cluster sites at Camden, Picton and Wallacia in the Sydney basin (see James 1979, 1982, 1984a) and transported to Hazelbrook in the Blue Mountains. Following sexing, examination of condition and tagging (see James 1984c), the butterflies were released *en masse*, usually within 24 hours of capture. The release site at Hazelbrook, 17 km east of Katoomba at an altitude of 650 m, was a tree-sheltered clearing on a south-facing slope. Trees were predominantly *Eucalyptus* spp. and the principal host plant of *D. plexippus* in the Sydney area, *Gomphocarpus fruticosus* (L.) (Asclepiadaceae), occurred commonly at the site. A thermograph situated 1.5 m above ground level provided a continuous record of temperature.

Observations on behaviour of butterflies at the site were made throughout the study, but particularly during the first two days following each release. Particular attention was paid to flight behaviour and dispersal from the site. Observations were also made on feeding, sun-basking, mating, courtship, roosting and oviposition behaviour. Temperature and weather conditions were recorded for all observations on behaviour.

An indication of degree of fidelity to the site by released butterflies was obtained by the recapture of tagged individuals. These individuals also provided information on direction and distance flown by migrants, as well as data on condition and longevity. Known sites of overwintering colonies of *D. plexippus* in the Sydney basin were inspected regularly for the presence of mountain-tagged individuals, and weekly recaptures were made of butterflies remaining at the release site.

Results

A total of 2,741 butterflies was released at the site from 24 March to 21 July and 79 (2.9%) were recaptured. Examination of data from each release indicates that migration occurred most effectively during March and April. Long distance (20-75 km) recaptures comprised 50% of total recaptures of butterflies released during these months (Table 1). Recaptures from releases made during May-July were predominantly local (< 5 km), or occurred at the site. During June and July a small, but noticeable pool of individuals persisted at the release site. This was indicated by an increasing incidence of recaptures at the site together with multiple recaptures of at least five individuals. In addition, sightings of tagged *D. plexippus* by members of the public or myself, were common within a radius of 5 km from the site during June-August.

Twelve butterflies (15.2% of recaptures) were recovered from distances ranging from 12-75 km, and were considered to be migrants (Table 2). All long distance movements occurred in a generally easterly direction into the Sydney basin. Three of the 12 recaptures were made at a single overwintering site at Wallacia, 30km southeast of the release point (see James 1979). Recaptures of migrants were made at intervals of 1-140 days after release, and all individuals were in a good condition when caught.

The behaviour of butterflies after release appeared to be strongly influenced by prevailing temperature and weather conditions. Sunny weather and ambient temperatures greater than 15°C resulted in rapid dispersal of released butterflies during March and April. During May-July when daily maximum temperatures generally remained below 15°C, dispersal flight behaviour was inhibited. When overcast conditions coincided with cool temperatures, flight activity was prevented. During sunshine at all

Table 1. Release-recapture and site temperature data for *D. plexippus* liberated at Hazelbrook during March-July 1984.

Release period	No. released	Total (%)	Number of recaptures: At site (% of total)	< 5km (% of total)	> 10km (% of total)	Daily mean temp. °C Max.	Min.
24.iii-7 .v	1168	18(1.5)	4(22.2)	5(27.8)	9(50.0)	19.6	10.8
15.v -2 .vi	1249	39(3.1)	18(46.1)	19(48.7)	2(5.1)	15.3	8.7
16.vi-28.vii	324	22(6.8)	16(72.7)	5(22.7)	1(4.5)	11.2	5.4
Totals	2741	79(2.9)	38(48.0)	29(37.0)	12(15.0)	15.4	8.3

Table 2. Release-recapture data for migrant *D. plexippus* released at Hazelbrook during March-June 1984.

Date released	Date recaptured	Location of recapture	Notes
31.iii	1.iv	Springwood (20km E)	24h between release and recap.
3.iii	14.iv	Parramatta (75km E)	
31.iii	11.v	Wallacia (30km SE)	recap. in overwintering colony
14.iv	24.v	Wallacia (30km SE)	recap. in overwintering colony
14.iv	20.vi	Londonderry (30km ENE)	
14.iv	3.ix	Londonderry (30km ENE)	20 weeks between release & recap.
30.iv	24.v	Wallacia (30km SE)	recap. in overwintering colony
30.iv	30.vi	Penrith (33km E)	
30.iv	21.vii	Warrimoo (26km E)	
13.v	11.vii	Faulconbridge (12km ENE)	
26.v	7.x	Valley Heights (25km E)	19 weeks between release & recap.
16.vi	22.vi	Springwood (20km E)	

temperatures below 20°C much open-winged basking occurred, with most individuals adopting a characteristic inverted V posture by holding the forewings down towards the body. Following release, most individuals congregated in large groups (50-200) on nearby trees; a characteristic behaviour of non-reproductive *D. plexippus* (Urquhart 1960). These formations persisted overnight when dispersal was slow. In addition, the small resident population that occurred during June and July invariably roosted in small groups of 2-6 individuals and often remained inactive by day.

Flight activity of butterflies in the days following each release was observed to be primarily of two readily distinguishable types. Individuals either flew within the release area with movement punctuated by turns, glides, feeding, basking and roosting, or they embarked upon rapid, easterly and uninterrupted (within visual range) flights which were considered to be dispersal flights. Occasionally high speed courtship flights were seen, but these never resulted in the loss of individuals from the site. Feeding upon flowers was commonly observed and one female was seen ovipositing on *G. fruticosus.*

Discussion

This study provides evidence of an easterly migration of non-reproductive *D. plexippus* during March-May 1984 from the Blue Mountains into the overwintering area of the Sydney basin. Long distance movements (>10 km) occurred mainly during warm days in March and April and ceased with the advent of cool-cold days in June and July. The latter conditions were associated with the formation of a non-migratory local population which exhibited non-reproductive overwintering behaviour such as communal roosting and site fidelity.

An autumn coastward movement of *D. plexippus* in New South Wales as part of a seasonal extension and contraction of range in eastern Australia was first suggested by Smithers (1977). Subsequent studies by James (1983, 1984a, 1984b, 1986), also indicated a tablelands to coast movement of non-reproductive *D. plexippus* prior to the establishment of overwintering colonies in the Sydney basin. However, this study provides the first data on pre-wintering migration of individual *D. plexippus.* Due to difficulties in locating sufficient numbers of wild mountain butterflies, or breeding an adequate supply of non-reproductive laboratory stock, butterflies were taken from clusters in the Sydney basin and transferred to the release site in the Blue Mountains. It was considered unlikely that this procedure would substantially alter natural behaviour of the butterflies. Migrants taken from transient or unstable cluster populations (James 1982, 1984b) would continue to display the same pattern and phenology of movement when transferred to the study site, less than 50 km away. They were in effect, taken back a "few steps" from the position they had reached when captured. One individual recovered in the Wallacia overwintering colony after release in the mountains was originally obtained from the same colony a few weeks earlier.

Due to the relative scarcity of host plants, summer abundance of *D. plexippus* in western areas of New South Wales is never great. The occurrence of larger populations in these areas would undoubtedly make interpretation of the seasonal movements of *D. plexippus* a lot easier. However, the data presented here together with the earlier work of Smithers (1977) and James (1983, 1984a, 1984b, 1986a), provide reasonable evidence for a coastward movement of non-reproductive *D. plexippus* during autumn, in central and southern areas of New South Wales. Most overwintering colonies are found in the Sydney basin, although they have been recorded as far south as Nowra (B. Holloway pers. comm.). The choice of specific overwintering sites which are used annually, raises a number of interesting questions. Are overwintering sites situated on migration "routes" These may occur as a result of the valley and hill topography of the Tablelands funnelling migrants into well defined migration "corridors". Do site colonisers produce an attractant pheronome creating a "zone of attraction" for later migrants? It is interesting to note that the three butterflies recovered in the Wallacia overwintering colony were the only migrants that moved southeast.

This study also provides further evidence for the role of temperature in the migration of *D. plexippus*. James (1984b) showed that migration was enhanced by warm (> 20°C) days and cold (< 10°C) nights, and was progressively inhibited as days cooled during autumn. A similar phenology occurred in the current study; migration occurred mainly in the warmer months of March and April, and was reduced or absent in the cooler conditions of May-July. A small resident population persisted at the site during June-July and showed behaviour characteristic of overwintering, non-breeding populations such as communal roosting and reduced flight activity (James 1979, 1984c). In addition, it was clear from numerous reports from other people and personal observations that a fairly sedentary population of tagged *D. plexippus* existed locally at this time. Butterflies at the site from May onwards spend a good deal of time engaged in thermoregulatory basking behaviour. The characteristic "delta" posture adopted by basking *D. plexippus* and observed commonly in this study, ensures maximum efficiency in absorption of radiant energy (James 1986b).

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